Educational Gaming: The Importance of Teacher Professional Development

by

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MODSIM World 2007 Conference & Expo
September 11-13

Educational Gaming

The Importance of Teacher Professional Development

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The Need to Engage Students

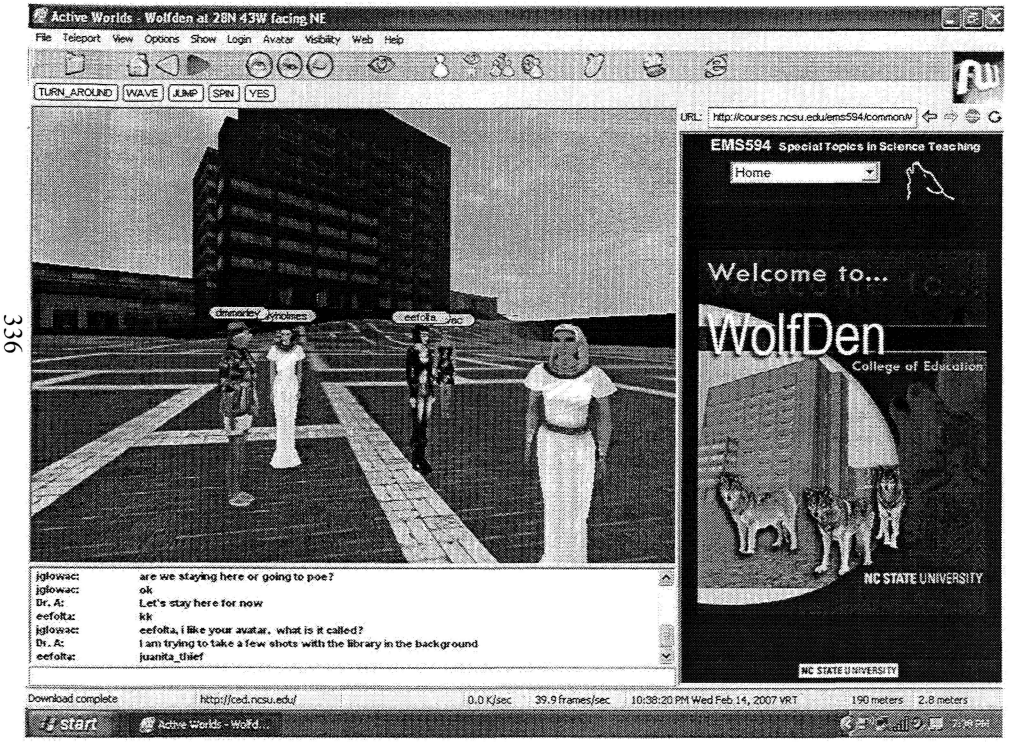
QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

Engaging?

- Learn by doing
- Learn through failure
- New Learning Styles
- Perspective taking
- Epistemic games
- Teacher Buy-In

QuickTime™ and a
H.264 decompressor
are needed to see this picture.

IGNITE



- Synchronous Online Course
- VLE
- Science Online
- Presence & Identity

The Wolf Den

QuickTime™ and a
Animation decompressor
are needed to see this picture.

HI FIVES

- NSF ITEST
- Impacting teachers & Students
- Grades 5-9
- Creating video game missions that align with science & math standards
- Team building
- Cascading leadership model

Student Creations

QuickTime™ and a
H.264 decompressor
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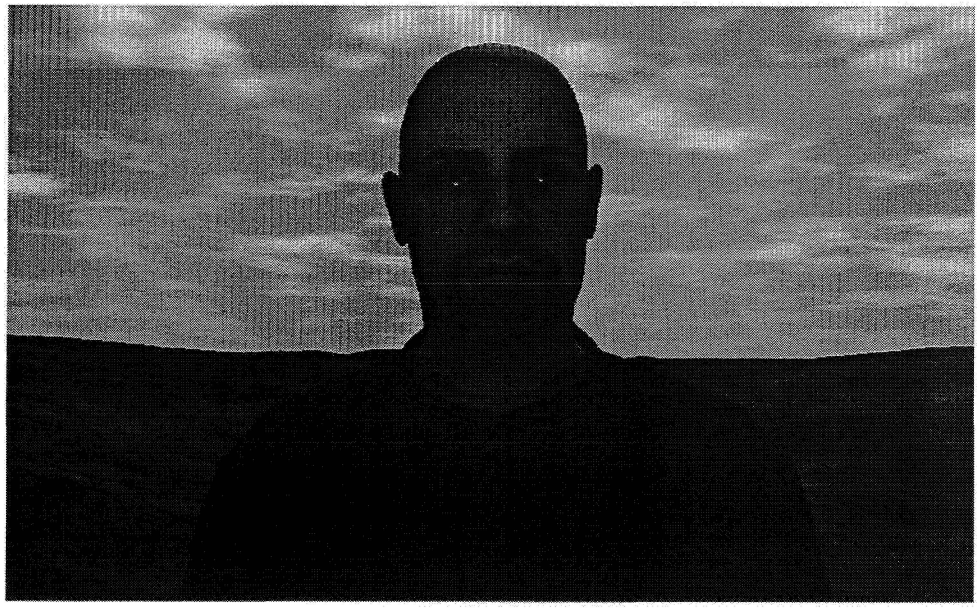
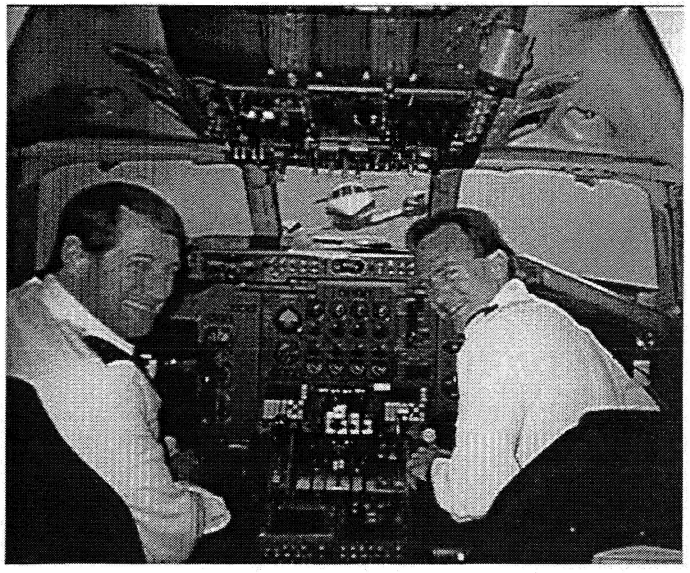
VOLT



- Design PBL around Science Ed, T & D & Business Management Cases
- VLE online learning
- More robust platform than IGNITE

Recommendations

- Teacher Buy-In
- Administration Buy-In
- 80+ hours of Pro D
- In School, After School, Home School
- Support, Support, Support!



"School's out. Computers are down."

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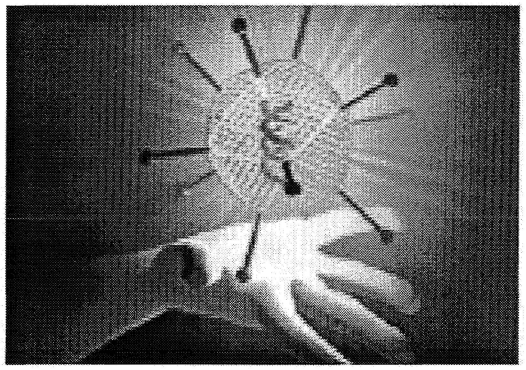
The Educational Potential of Haptic Augmentation

James Minogue
North Carolina State University

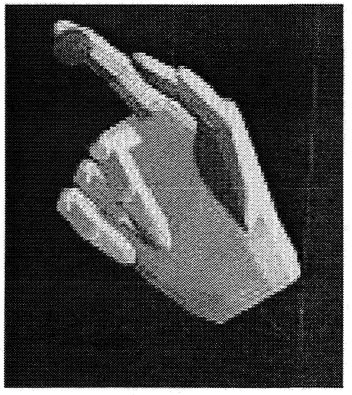
"It is a truism of our educational creed that sensory impressions based on object lessons and motor response form the primary basis of thought in dealing with the later materials of knowledge."

(McMurray, 1921, p. 3)

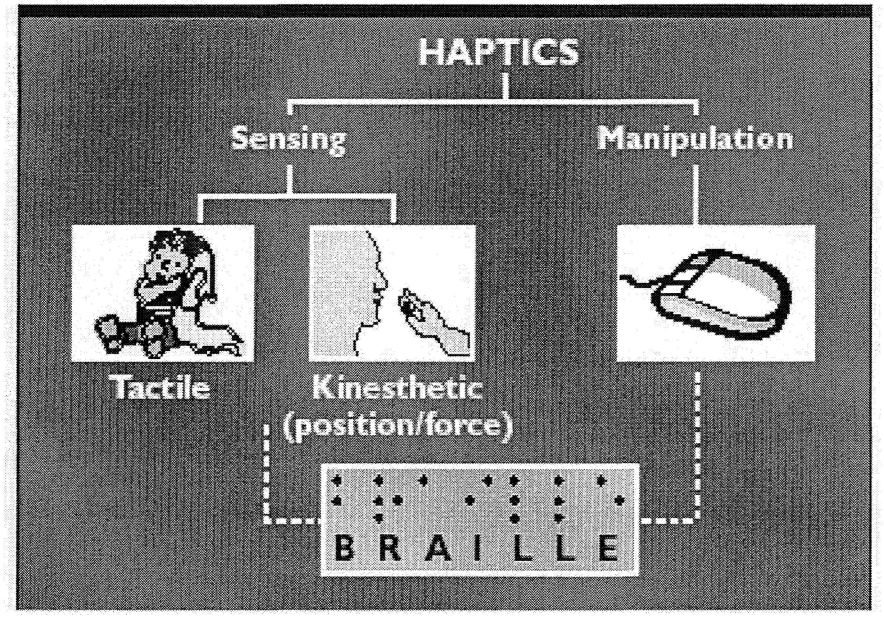
Overview:



- What is Haptics?
- Existing Interfaces
- Touch & Cognition
- Simulated Learning Environments
- Current Impediments
- The Future of Haptic Augmentation in Education

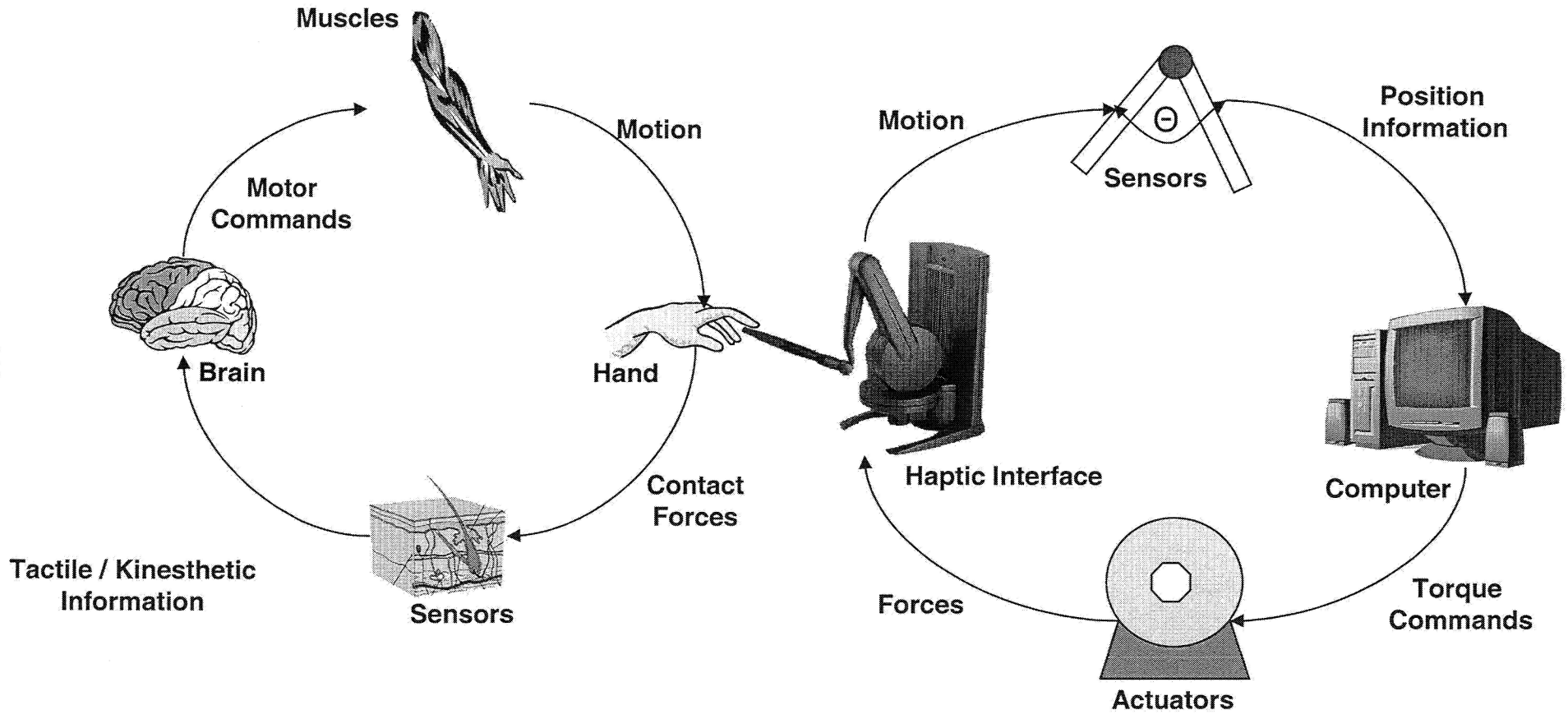


What is 'Haptics'?



The study of touch and the human interaction with the external environment via touch.

What is 'Haptics'?

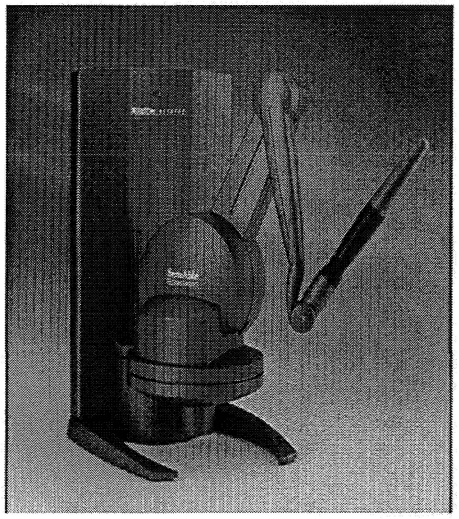


Human Haptic Subsystem

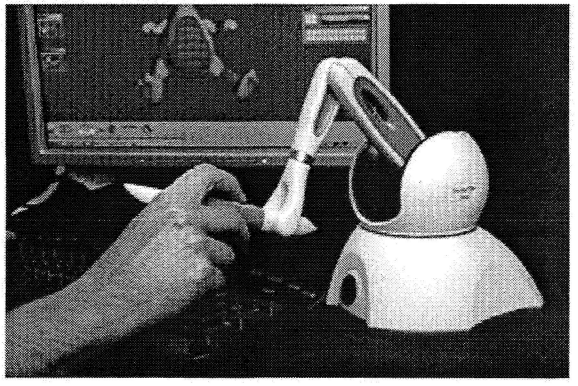
Machine Haptic Subsystem

Point-probe Devices:

- Tracks the *x, y,* and *z* coordinates and pitch, roll, and yaw of the virtual point-probe as it moves about a 3-D workspace.
- Actuators communicate forces back to the user's fingertips as it detects collisions with virtual objects, simulating the sense of touch.



SensAble technologies



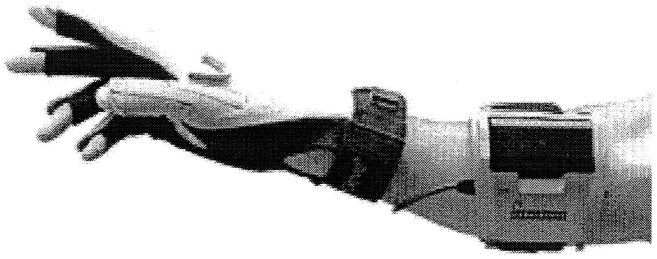
Data Gloves:

- Uses resistive bend-sensing technology to accurately transform hand & finger motions into real-time joint-angle data

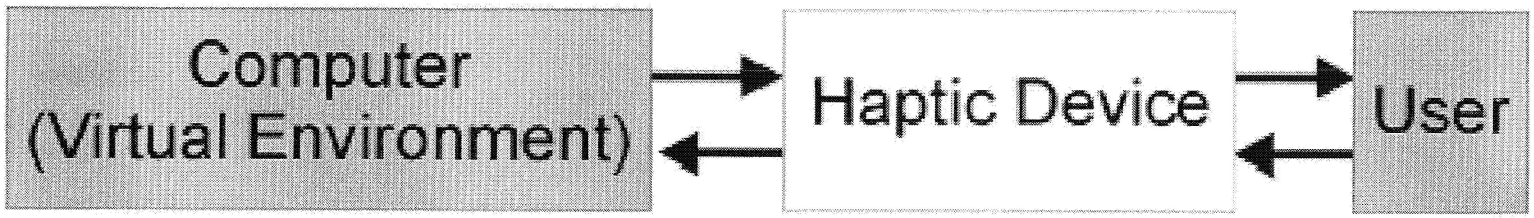
- Position & orientation of hand & fingers are tracked in the virtual 3-D environment

- *CyberGrasp*- a lightweight, force-reflecting exoskeleton that fits over a *CyberGlove* & adds resistive force feedback to each finger

Immersion



All Haptic Interfaces…



offer the **bi-directional exchange** of information between a user and the haptic device...but this is not easily achieved.

Common requirements include:

- sensing the state of a haptic interface
- computing haptic collision detection
- updating the status of the virtual object(s)
- computing and displaying the necessary forces and/or torques to a user

Typically performed at rates of 1 kHz or higher

Haptics Research Base:

Inherently multidisciplinary:

- engineering
- robotics
- computer science
- developmental & experimental psychology
- cognitive science
- educational technology (to a much lesser extent)

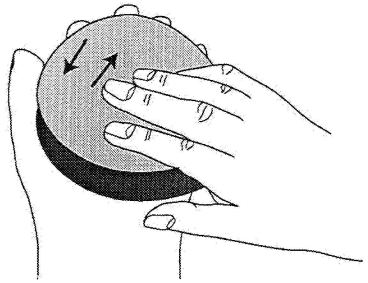
Touch & Cognition:

- The sensory channel of touch receives information, not just sensations.

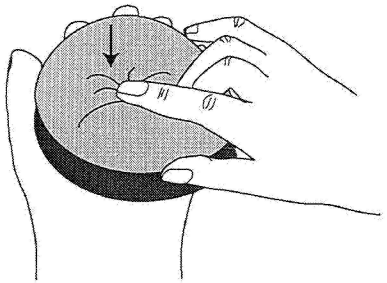
- The extensive work of Lederman & Klatzky led to the development of ***exploratory procedures*** (EPs).

Touch & Cognition:

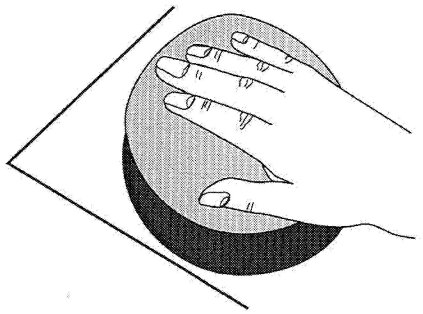
LATERAL MOTION/ TEXTURE



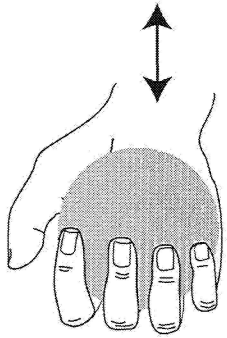
PRESSURE/ HARDNESS



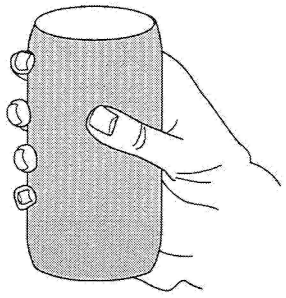
STATIC CONTACT/ TEMPERATURE



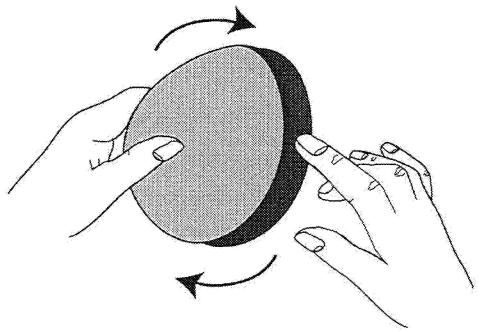
UNSUPPORTED HOLDING/ WEIGHT



ENCLOSURE/ GLOBAL SHAPE, VOLUME



CONTOUR FOLLOWING/ GLOBAL SHAPE, EXACT SHAPE

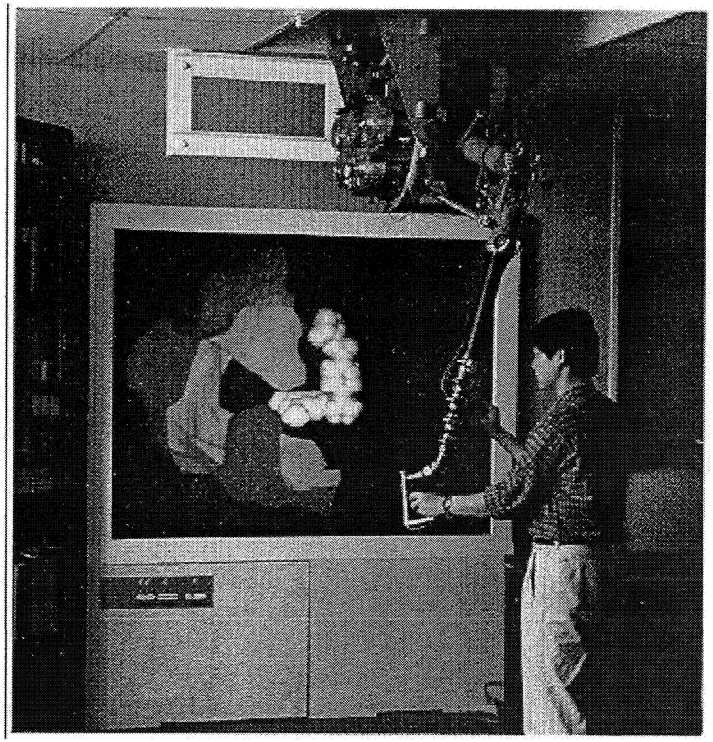


Touch & Cognition:

- Haptics is oriented toward the perception and subsequent encoding of *material properties*.
- Haptics is thought to be superior to vision in perceiving of properties such as **texture**, **weight**, **hardness**, **compliance**, **elasticity**, and **viscosity**.
- Vision dominates in the perception *geometric properties* like **shape** and **size** (and color).

Simulated Learning Environments:

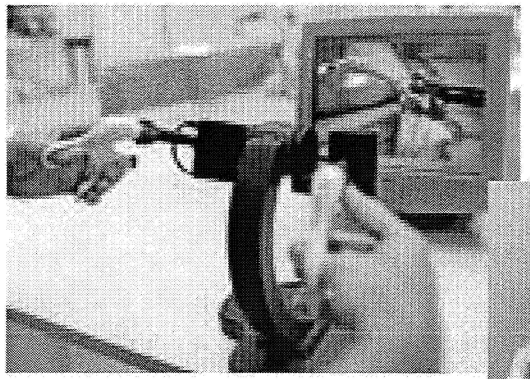
- Project **GROPE-**Brooks, Ouh-Young, Batter, & Kilpatrick (1990)
- 12 experienced biochemists
- Impact of adding haptic feedback to a 6-D (i.e., *x, y,* and *z,* pitch, yaw, and roll) molecular docking task

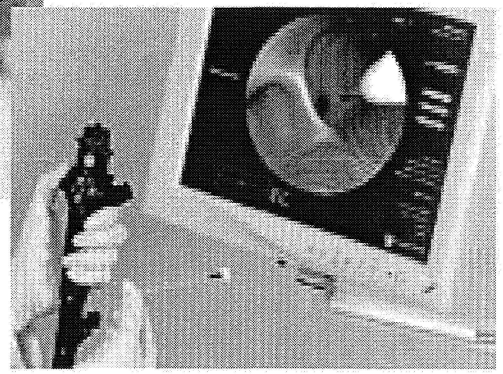


Simulated Learning Environments:

- ***Flight Simulators***

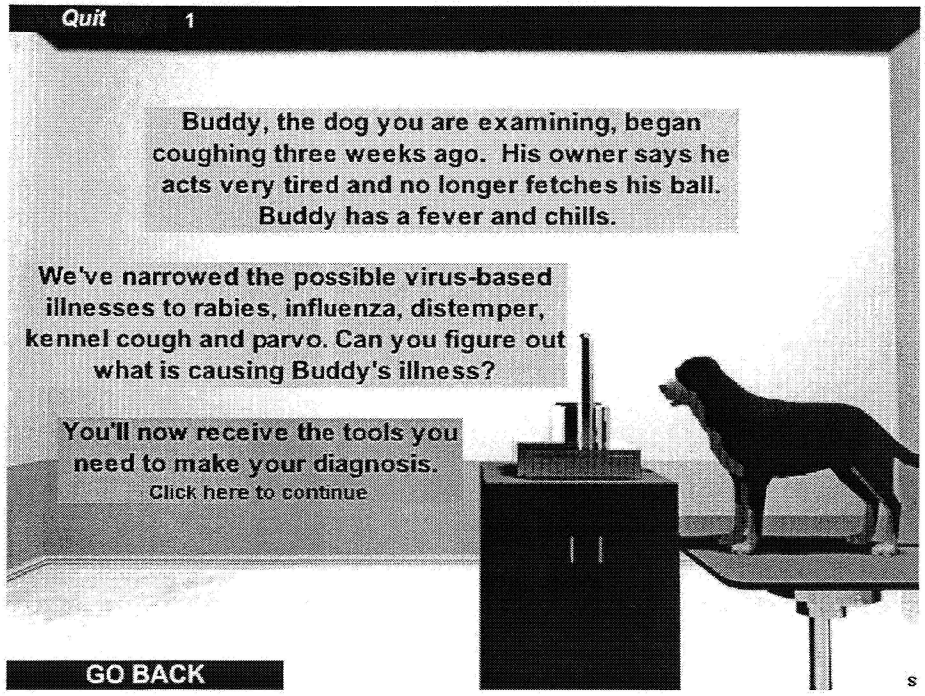
- ***Medical Training Simulations***
  - Endoscopic Surgery
  - Laparoscopic Surgery
  - Needle Insertion & suturing
  - Dental





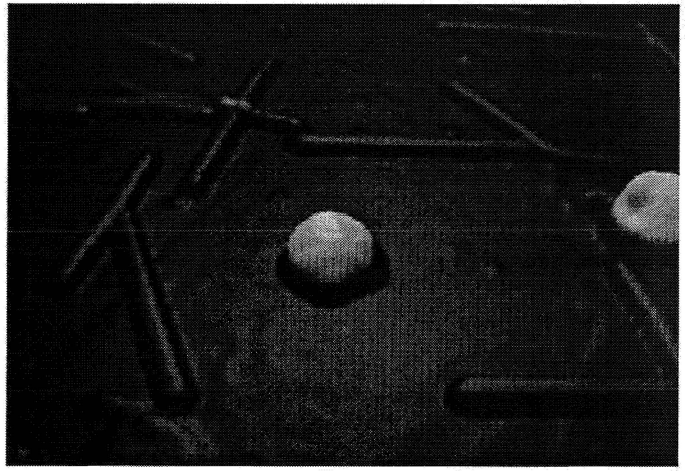
Simulated Learning Environments:

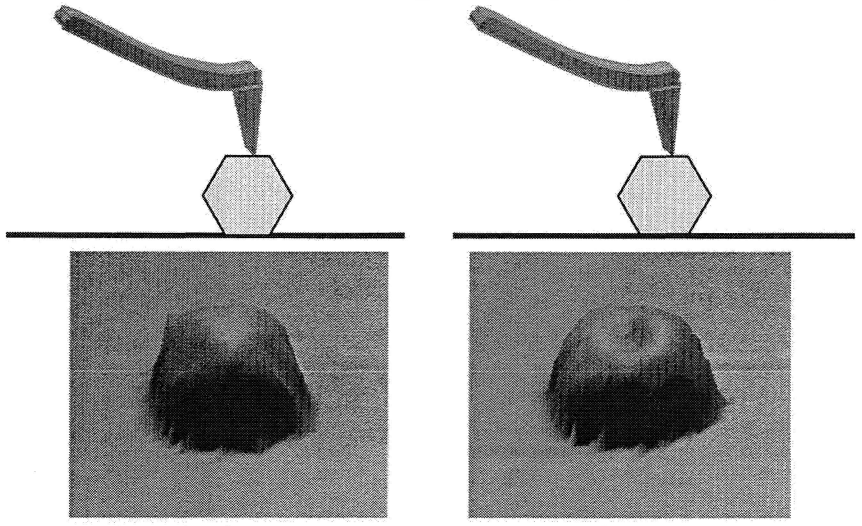
Investigating Viruses: The Mystery of the Sick Puppy-



Students act as veterinarians & are given the challenge of diagnosing the virus that has infected a puppy.

Simulated Learning Environments:





Before

After

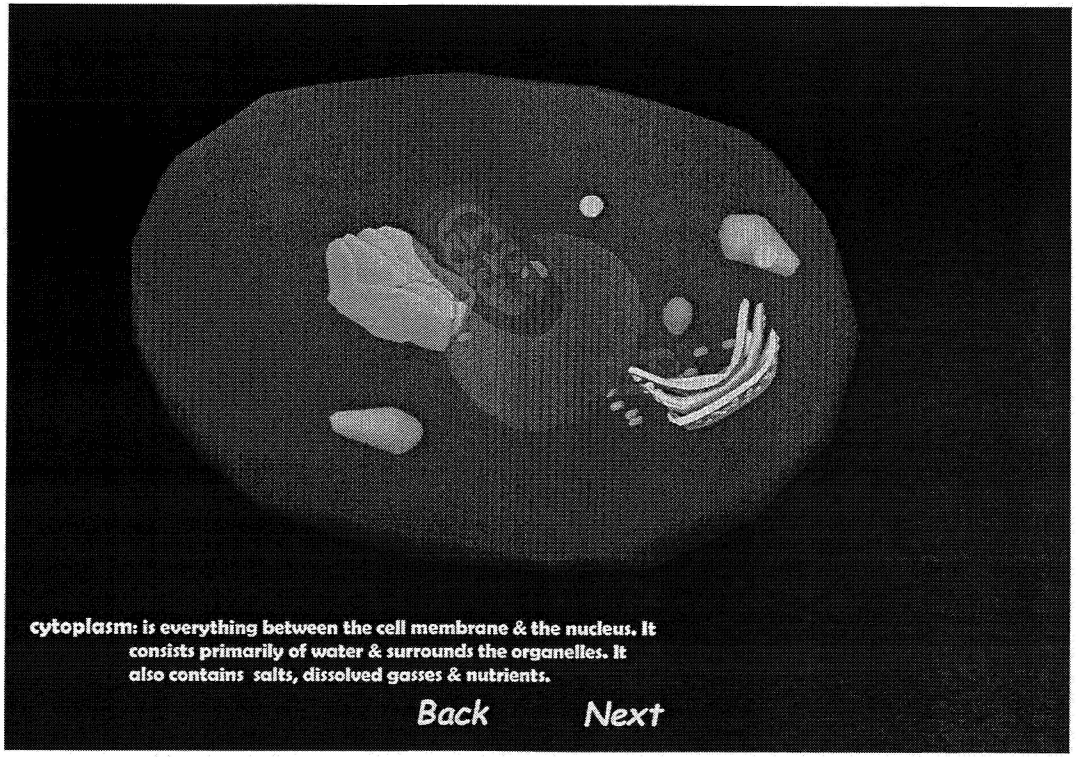
They can feel and manipulate (poke, push, & cut) a virus to gather information about it's size, shape, & structure.

Simulated Learning Environments:

The ***Cell Exploration*** program:

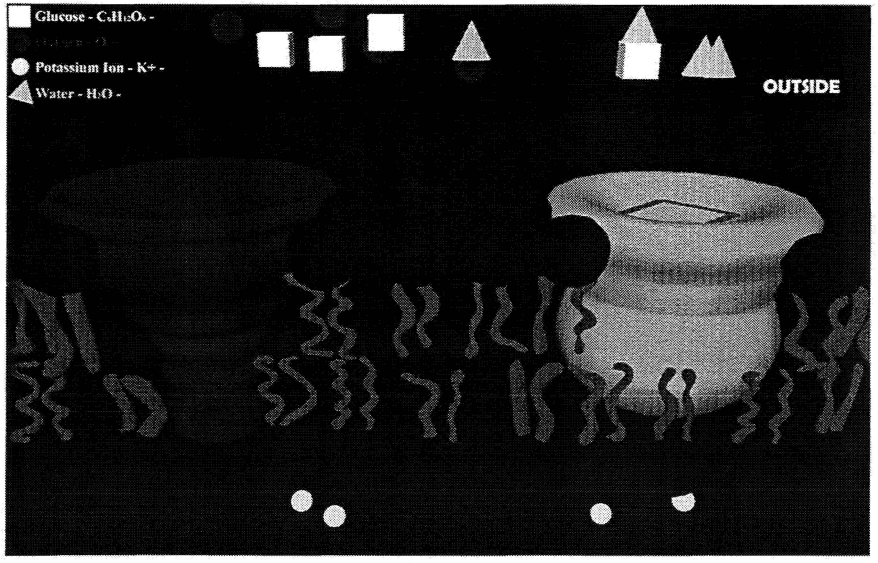
- Students can zoom in or out & rotate the 3-D model.

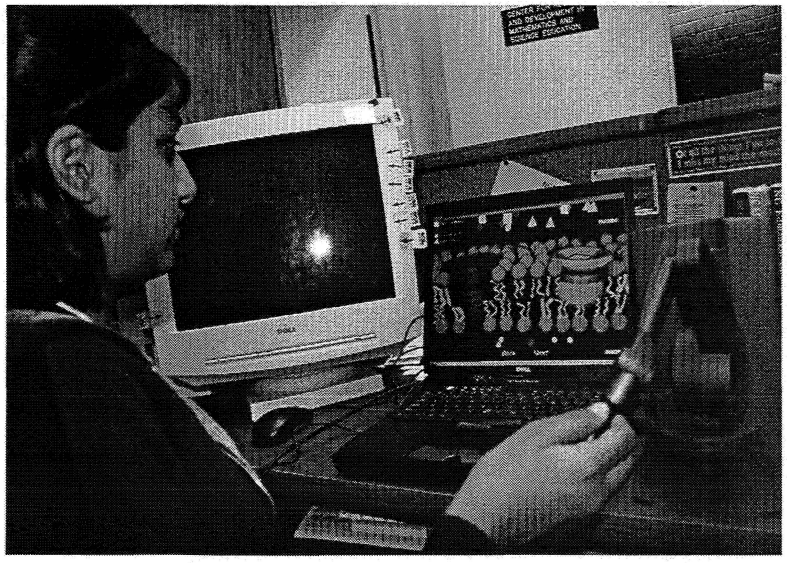
- They can "feel" the *flexibility* of the cell membrane, the *viscosity* of the cytoplasm, the *texture* of the rough ER…



Simulated Learning Environments:

- Investigate the mechanisms behind passive transport.
- In a game-like scenario students are challenged to move molecules across the cell membrane until equilibrium is reached.





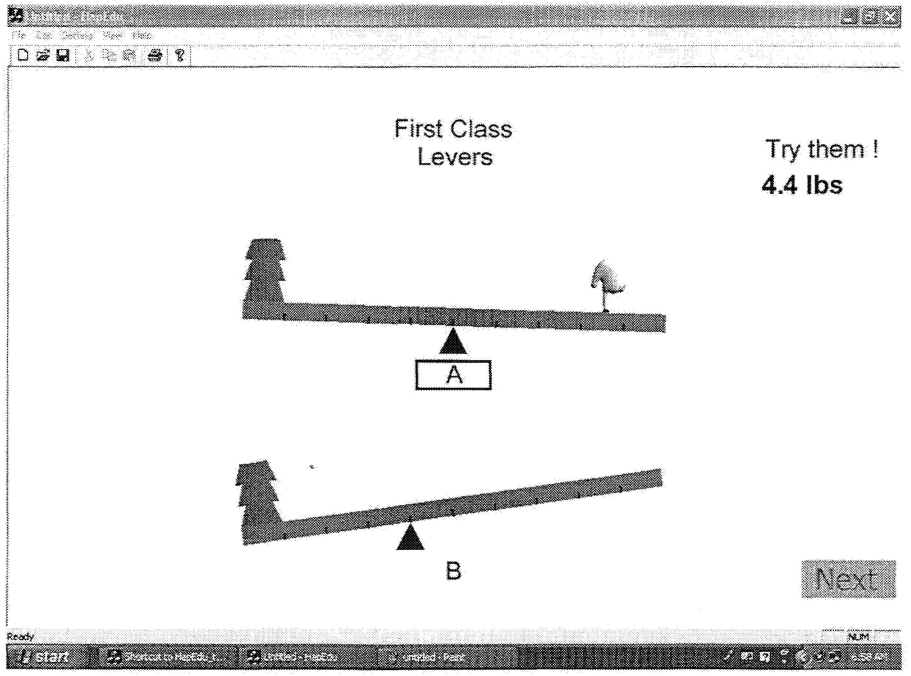
Simulated Learning Environments:

The ***Haptic Lever*** Program:

- students manipulated the fulcrum location, beam length, and amount of load placed on a lever

- a comparison lever of the same type-but with fulcrum location, beam length, or load varied-was generated by the program & students were asked to chose which lever would take more force to move the load.

- students received force feedback via a PHANToM Omni.



Impact on Learning???

Affective influences (i.e. more interesting & engaging) and improved spatial orientation have been detected but a ***cognitive impact*** has been harder to measure.

- ***Kinesthetic knowledge?***
- ***Embodied knowledge?***
- ***Tactile knowledge?***

Teaching with Haptics…

There are numerous impediments to its widespread use in education:

- ***Perceptual***
- ***Technological***
- ***Methodological***

Technological Impediments:

- Constraints of point-probe exploration on student processing of haptic information

- Imagine engaging in contour following to obtain shape information with a single point of contact…

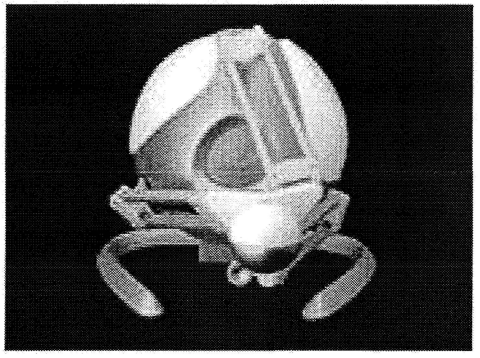
Technological Impediments:

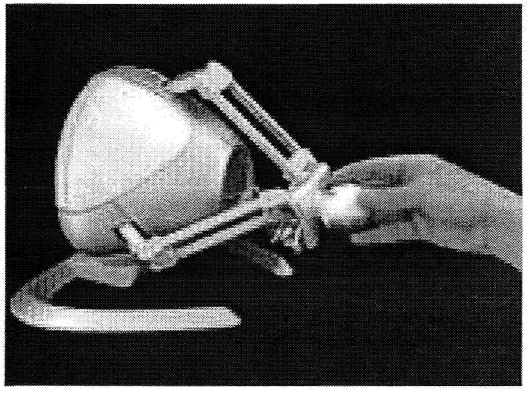
$$$$$$$$$$$$$$$

Novint Technologies, Inc.- ***Falcon***

NOVINT

- 3-DOF device
- Designed to retail for $100 in mass market quantities

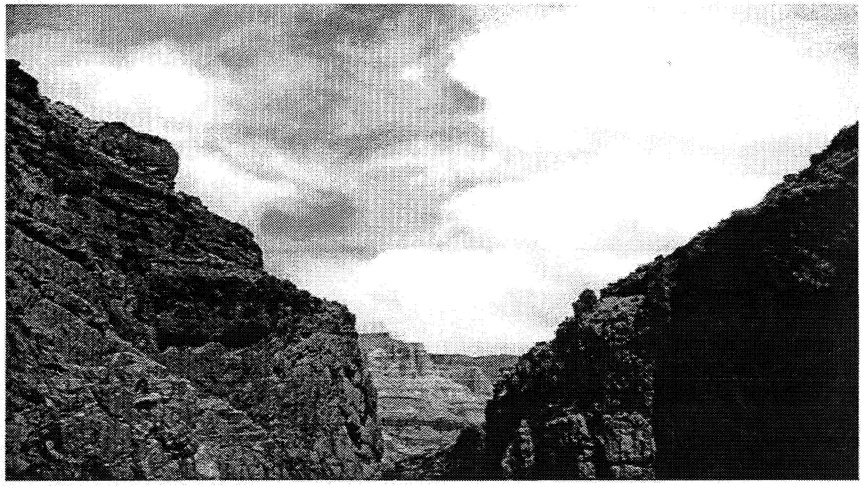




Methodological Issues:

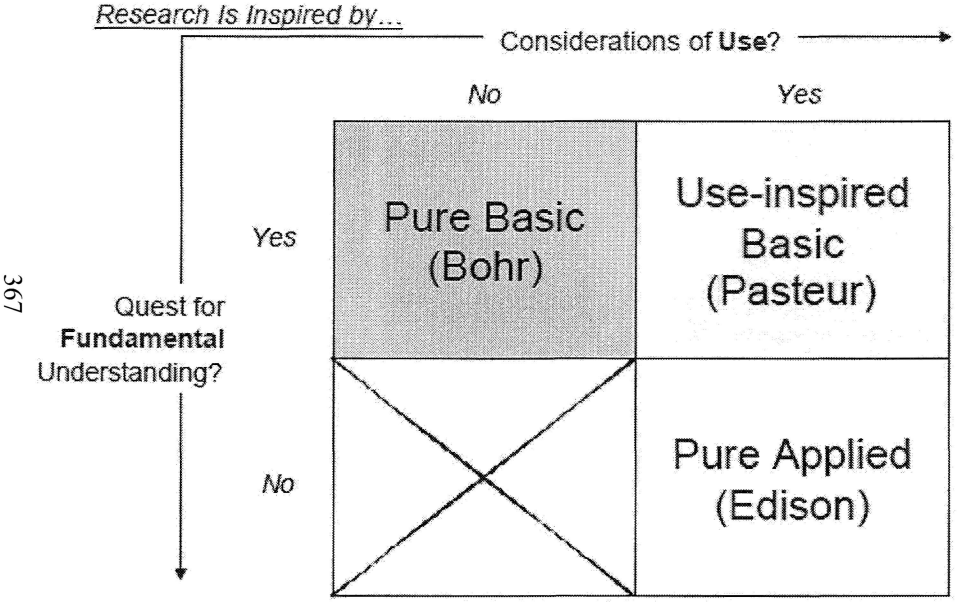
A chasm currently separates two equally important types of research in the field of haptics.

pure basic research



application or intervention studies

Future of Haptics in Education:

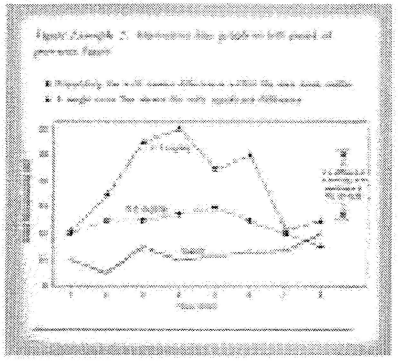


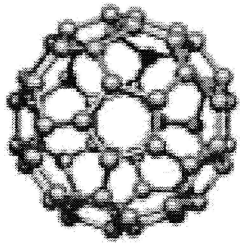
Stokes, Donald E. "Pasteur's Quadrant: Basic Science and Technological Innovation," Brookings Institution: 1997.

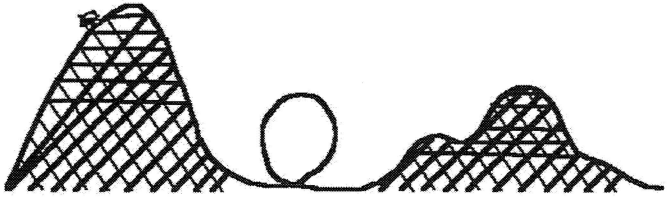
- systematically link the fundamental research on haptic perception & cognition with the research on haptics as an intervention for change
- apply the knowledge creation of basic research to achieve beneficial effects in real-world classrooms

Future Work:

- Explore other '**Haptically Rich**' learning environments.
  - ***Mathematics***: tangible graphs & touchable curves to teach to the visually impaired
  - ***Chemistry***: "feeling" attractive & repulsive forces associated with various compounds
  - ***Physics***: "feeling" of forces such as gravity & friction at the macro- & microscopic level







'Haptically Rich' NCSCS Content:

- **Grade 4:**

3.01 Observe and investigate the ***pull*** of magnets on all materials made of iron and the ***pushes*** or ***pulls*** on other magnets.

- **Grade 5:**

2.01 Identify and analyze ***forces*** that cause change in landforms over time including: wind & gravity

4.02 Evaluate how ***pushing*** or ***pulling forces*** can change the position and motion of an object.

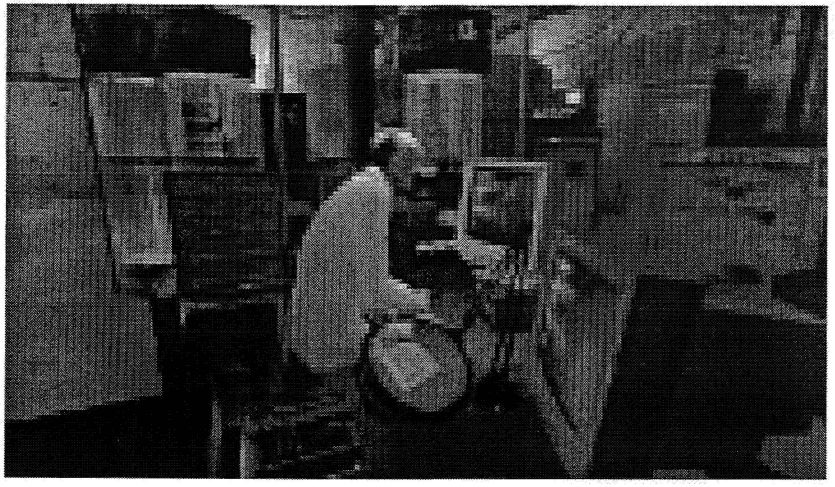
4.04 Determine that an ***unbalanced force*** is needed to move an object or change its direction.

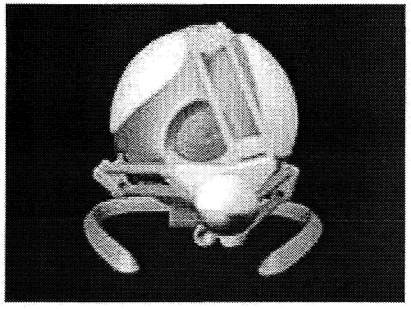
4.05 Determine factors that affect motion including: ***force***, ***friction***, ***inertia***, ***momentum***

- **Grade 6:**

6.03 Analyze sound as an example that ***vibrating materials*** generate waves that transfer energy.

Future Work:





ASPECT- **A**dvancing **S**cience **P**erformance with **E**merging **C**omputer **T**echnology

- Serious Games + Haptics
- Built to align cover content from *FOSS* & *STC* modules
- Elementary teachers an integral part of the game design & assessment development

Potential Benefits:

- **Students**
  - Increased interest in science & technology
  - Deeper understandings of the content covered?

- **Teachers**
  - Increased interest in science & technology
  - Deeper understanding of the content they teach & methods of assessment?

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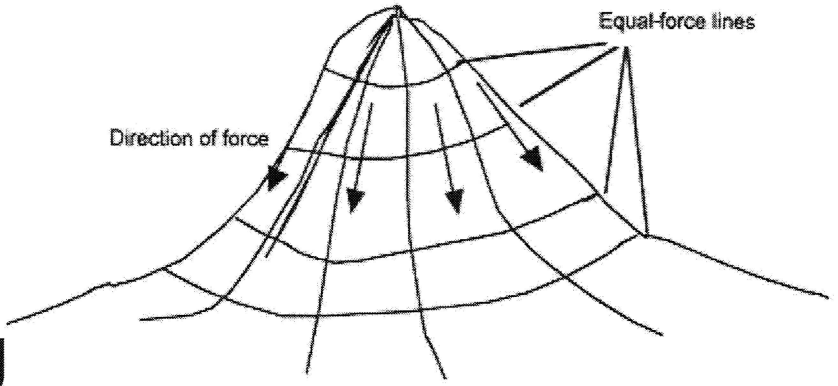
Embodied knowledge?

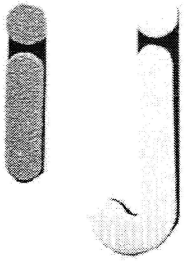
- Reiner (1999) studied the role of tactile perception in learning about forces and fields
- tactile trackball & computer simulations of force fields
- drawing tasks analyzed
- embodied knowledge… previously unexploited nonpropositional knowledg

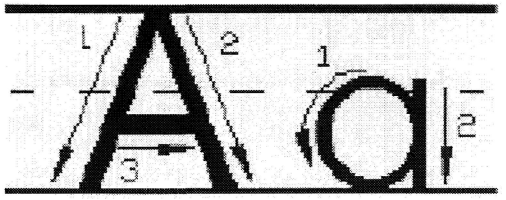


Tactile knowledge?

- Florence, Gentaz, Pascale, & Sprenger-Charolles (2004)
- multisensory trace of foam letters
- positive effects on the understanding

  & use of the alphabetic principle
- helped students establish the link between the representations of the letters & their corresponding sounds





Basic Research:

- voluminous & rich literature base
- conducted primarily by developmental & cognitive psychologists
- attempt to identify & detail the underlying principles & processes of haptics
- often conducted in pristine & "uncluttered" laboratories with relatively small samples of eager participants.
- studies are methodologically rigorous, include sophisticated statistical analyses, & provide sound evidence-based results.

Intervention Studies:

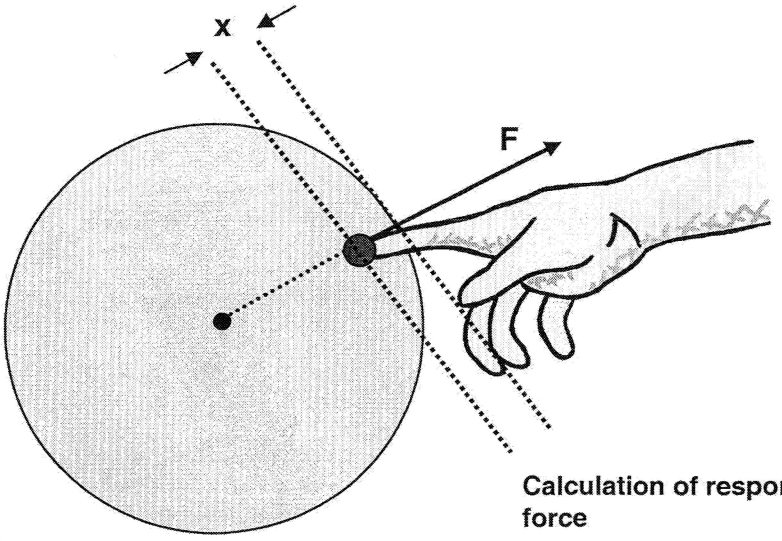
- scant collection that have directly investigated the efficacy of haptically augmented instruction
- mainly educators & educational technologists
- attention is given to issues of practice & users' experiences with the emerging technology
- research methodologies employed are varied & at times sound, often capturing valuable qualitative & (to a lesser extent) quantitative data
- they have resulted in little empirical evidence for the existence of a cognitive impact of haptic technology

Haptic Rendering

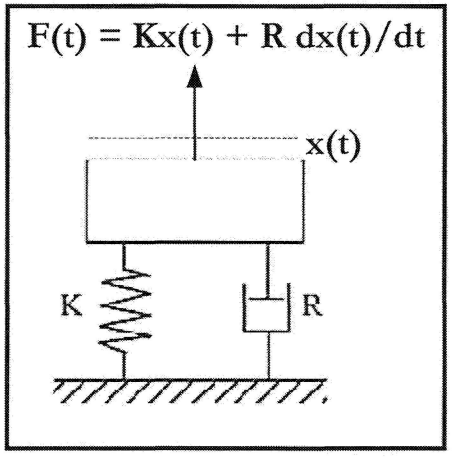
The process of calculating & sending force values to be displayed at the haptic device…

Spring-damper model:

- The response force is calculated using *Haptic Interface Point's* (HIP) penetration into the virtual object
- Each object has a spring co-efficient, K, and damping factor, R.



Calculation of response force

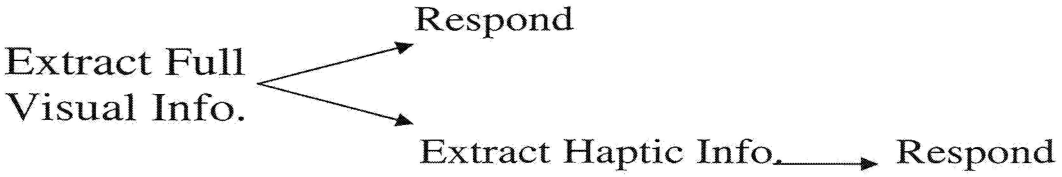


Spring-damper model

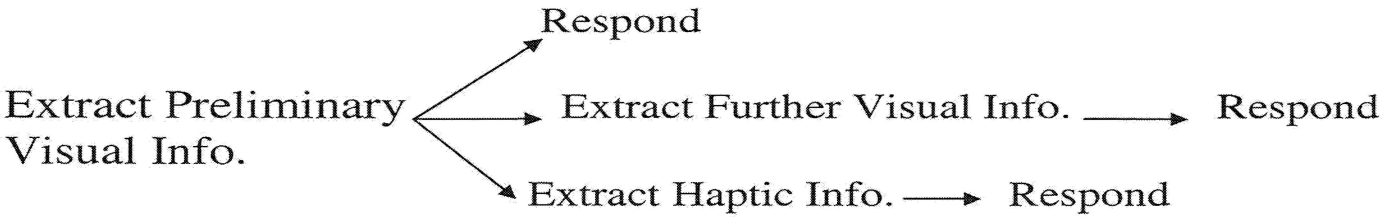
Perceptual Constraints:

- Haptic exploration in the presence of vision
- Klatzky, Lederman, and Matula (1991) raised this issue of '**modality specificity in perceptual encoding**'

Visual Dominance:

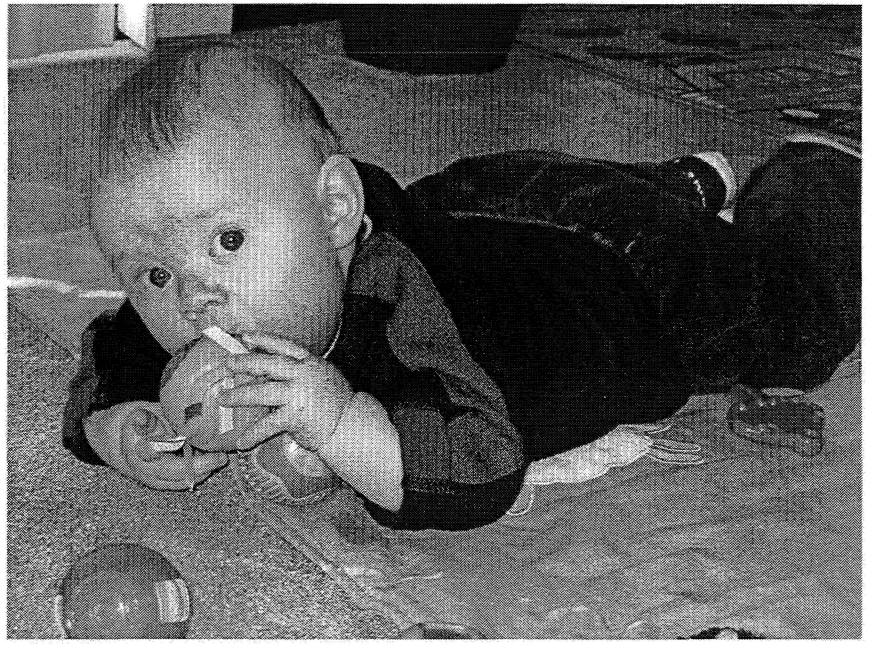


Visual Preview:



Touch Early On:

- Around 5 months children begin to pick up objects within their reach and explore them both orally and manually.



- Research has suggested that babies (6-9 months of age) are able to encode, hold in memory, and recognize an object's haptic properties (e.g. shape, substance, weight, size, and volume.)

V. Tools and User Applications Session

Tools and Applications: Innovative Uses of Game-Based Learning